

**CLAIMS**

1. A process of enhancing surface bonding properties of a substrate comprising the steps of substantially simultaneously:

5 depositing combustion ions upon the substrate substantially immediately upon generation the combustion ions; and  
depositing corona ions upon the substrate substantially immediately upon generation of the corona ions.

10 2. The process according to claim 1 wherein the combustion and corona ions are deposited in substantially sequential process steps.

3. The process according to claim 1 wherein the combustion ions are deposited in a substantially common process step.

15 4. The process according to claim 1 further comprising the steps of:  
generating the combustion ions with a flame wherein said step depositing the combustion ions upon the substrate occurs substantially immediately thereafter; and  
generating the corona ions with an electrical field wherein said step of depositing the corona ions upon the substrate occurs substantially immediately thereafter.

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5. A process of enhancing surface bonding properties of a substrate comprising the steps of substantially simultaneously:

treating the substrate with combustion ions; and  
treating the substrate with corona ions.

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6. The process according to claim 5 further comprising the steps of:  
generating the combustion ions with a flame wherein said step of treating the substrate with the combustion ions occurs substantially immediately thereafter; and  
generating the corona ions with an electrical field wherein said step of treating the substrate with the corona ions occurs substantially immediately thereafter.

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7. The process according to claim 5 wherein the substrate is treated with the combustion and corona ions in substantially sequential process steps.

8. The process according to claim 5 further comprising the steps of:  
generating the combustion ions with a flame head assembly located at a first location wherein said step of treating the substrate with the combustion ions occurs substantially immediately thereafter; and  
generating the corona ions with coronal head generating assembly located at a second position wherein said step of treating the substrate with the corona ions occurs substantially immediately thereafter.

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9. The process according to claim 8 wherein the first and second locations are in close proximity and the process further comprises the step of  
insulating the corona head from the flame head with an air knife.

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10. The process according to claim 8 wherein the substrate is cylindrical and the process includes the step of
- rotating the cylindrical substrate, and further wherein
- the first location of the flame head is positioned opposite to the second location of the
- 5 corona head relative to the rotating cylindrical substrate, and
- the rotating cylindrical substrate is treated by the flame head with combustion ions at the first location while the substrate is further treated by the corona head with corona ions at the second location.
- 10 11. The process according to claim 10 further comprising the step of
- cooling air; and
- injecting the cooled air from the corona head into the corona ions thereby cooling the substrate.
- 15 12. The process according to claim 5 further comprising the step of
- generating the combustion ions and the corona ions with a combination head for simultaneously generating a corresponding flame and corona in a substantially common location.
- 20 13. The process according to claim 12 further comprising the steps of:
- determining a presence of the corona;
- providing a combustible gas for generation of the flame in response to said step of determining; and
- igniting the combustible gas with the corona.

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14. A combination flame and corona head for enhancing surface bonding properties of a substrate comprising:
- a corona electrode for generating a corona by electrically charging an area between said electrode and a complementary electrode; and
  - 5 at least one opening in the corona electrode for providing a combustible gas in the area of the corona,
  - said corona electrode facilitating generation of a corona and a flame within a common area.
- 10 15. The combination flame and corona head according to claim 14 wherein the substrate is located between said corona electrode and the complementary electrode, and
- the substrate is simultaneously treated with corona ions from the corona and combustion ions upon ignition of the combustible gas
  - 15 thereby enhancing the surface bonding properties of the substrate.
16. The combination flame and coronal head according to claim 15 wherein the complementary electrode is cylindrical,
- the combination head generates the corona and flame in the common area
  - 20 corresponding to an arc portion of the cylindrical complementary electrode, and
  - said corona electrode has a curved surface corresponding to the arc portion of the cylindrical complementary electrode.

17. The combination flame and corona head according to claim 16 wherein the combination head is a component of a device for enhancing surface bonding properties of a plurality of cylindrical substrates and the device further comprises

5 a plurality of regularly spaced cylindrical complementary electrodes moving in a planar direction relative to said combination flame and corona head wherein each of the plurality of substrates is cylindrical and removably attaches to each of the plurality of corresponding complementary cylindrical electrodes; and

a controller for pausing the planar movement of each of the plurality cylindrical complementary electrodes at a predetermined position relative to said combination head  
10 thereby providing a predetermined gap of substantially constant distance between the curved electrode of the combination head and each cylindrical complementary electrode while paused in close proximity, while providing for the planar movement of the cylindrical complementary electrodes relative the combination head without movement of the combination head.

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18. An enhanced head for generating a corona comprising:

a corona electrode for generating an ion field when electrified and placed in proximity with a complementary electrode, the ion field for treating the surface of a substrate located between the corona electrode and complementary electrode; and

20 an orifice for generating an air jet for constraining the location of the ion field.

19. The enhanced head according to claim 18 wherein

said corona electrode has two parallel sides; and

said orifice includes a first and second opening for generating first and second air jets  
25 in substantial proximity with the two parallel sides wherein the ion field substantially contained within the first and second air jets.

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20. The enhance head according to claim 18 wherein  
said corona electrode has a leading edge and a trailing edge,  
the substrate moves through the generated ion field by entering at the leading edge  
and exiting at the trailing edge and
- 5            said orifice includes an opening for generating a trailing edge air jet in substantial  
proximity with trailing edge of said corona electrode wherein the ion field is substantially  
contained within the trailing edge of the air jet.
21. The enhanced head according to claim 20 further comprising
- 10           a flame orifice located in substantial proximity with the leading edge of said corona  
electrode for generating a flame for treating the surface of the substrate.
22. The enhanced head according to claim 20 wherein the ion field heats the substrate and  
the air jet further cools the substrate upon exiting the ion field.
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23. The enhanced head according to claim 22 further comprising an air cooler connected  
to the enhanced head for the air cooling air prior to passing through the opening of said  
orifice.